# 2003 Run: Physics Goals

RHIC Retreat

Montauk Point

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# Summary

- In the future* the program needs will be dominated by the highest available $\int L\,dt$
  - Spin
  - High $p_T$
  - Charm and heavier flavors
  - Multi-strange states

* The future has already started!

- In the near term experiments will also ask for numerous different running conditions at modest $\int L\,dt$
- The best chance of meeting these needs will require significant accelerator development time
  - Average L, lifetime, diamond size, up-time, etc.
  - dt (calendar time) is hard to come by; $L_{avg}$ & availability are the way to maximize the physics output
- A key issue is balancing development with near term running

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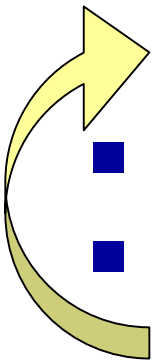
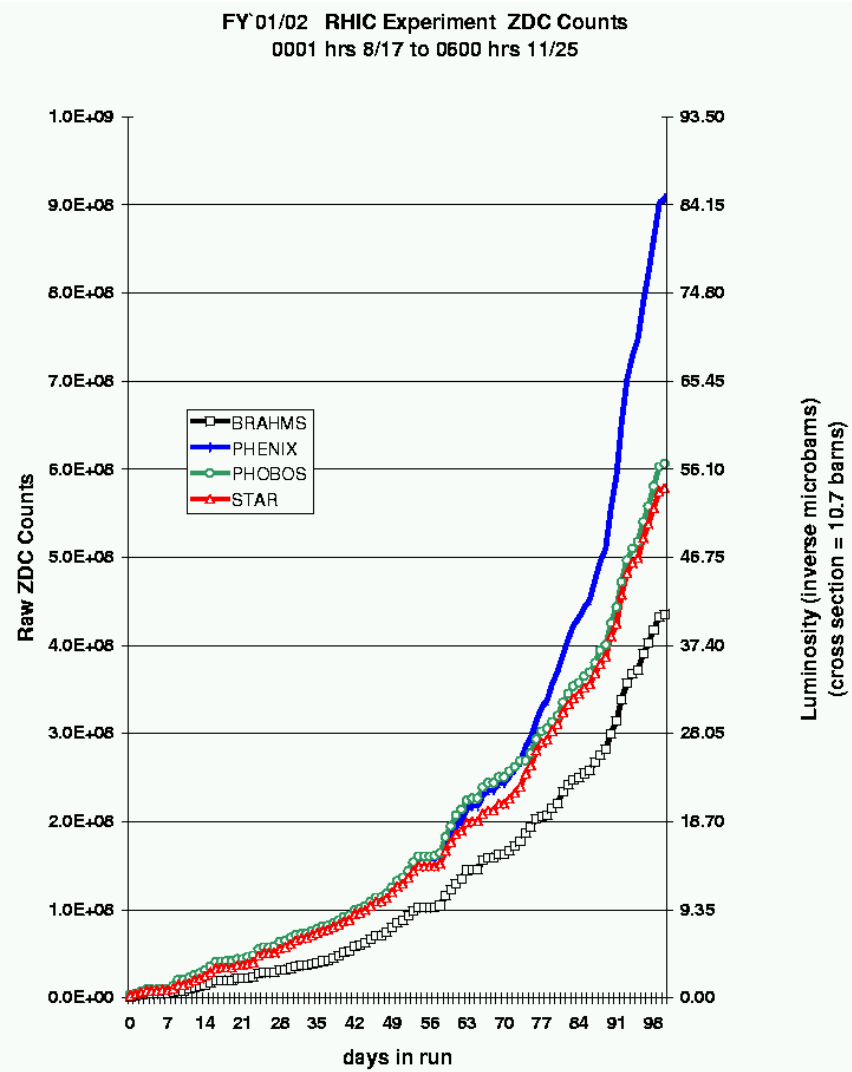
- 2001/2002 data set and expected physics results
  - Which goals will be met and which missed?
- The RHIC Beam Use Proposal (RBUP) Process
  - Catch 22
- The Long Range Plan Strawman
- Assumptions about running conditions
  - Are these realistic?
- Physics goals and stretch goals for the 2003 run
- Summary

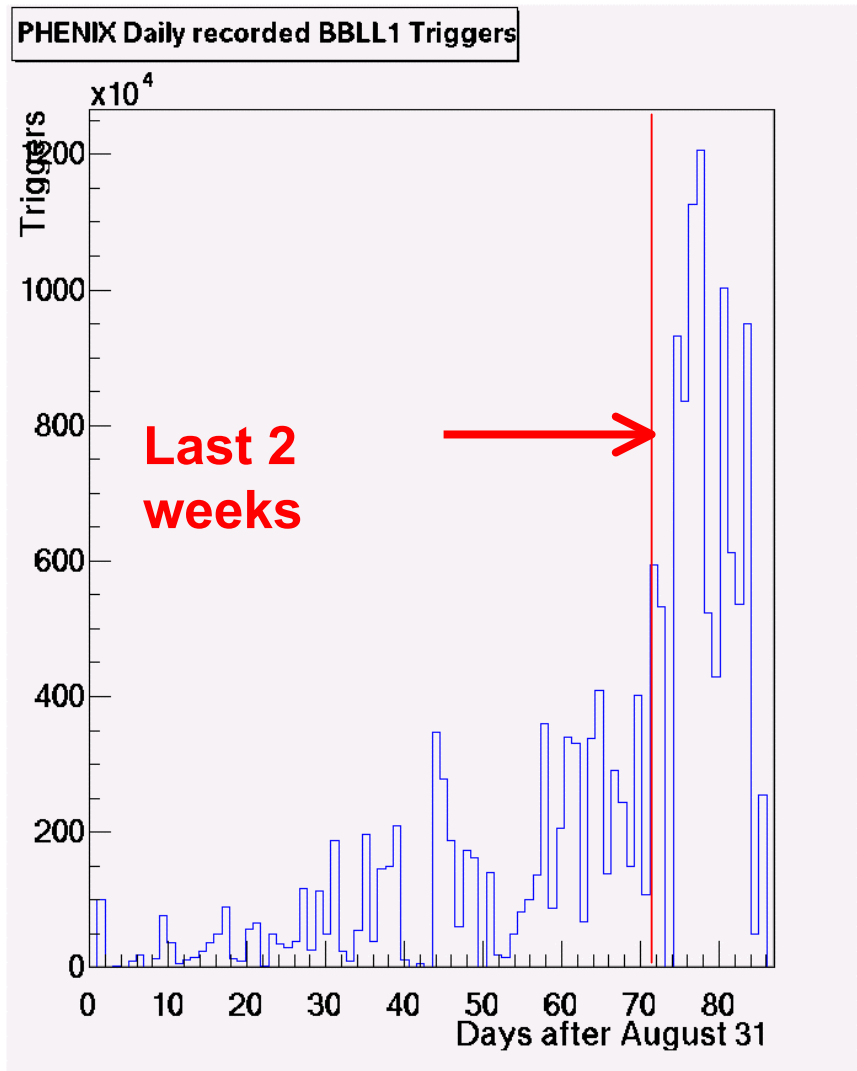


# 2001/2002 data set, expected results

- Au-Au:40 to 80 $\mu b^{-1}$ delivered, □ half "observed"
  - p-p similar relative to expectations
- PHENIX: μSouth, STAR: 1st EMCal piece, PHOBOS: 2nd arm, BRAHMS: fwd. spectrometer @ full pwr.
- Data in hand to meet (more or less) the soft physics goals set forth in the 2001 RBUPs
  - Global hadronic signals
  - Light vector mesons
  - Moderate $p_T$
- High $p_T$, rare processes will not be accessible at RBUP Levels. In hand:
  - Few hundreds of J/ψ
  - Hadron $p_T$ □ 10 GeV/c
  - Not quite comparable reach in the p-p comparison data
- QM03 should be another success for RHIC!

# ZDC counts and PHENIX triggers/day



# RHIC Beam Use Proposal Process

- RBUPs will be due this summer, after much analysis of the existing data
  - ALD, with PAC advice, will set the program
- This meeting will hopefully generate **realistic expectations of accelerator performance** → guidance for writing the RBUPs
- Catch 22: **realistic physics goals from the experiments** cannot be given at this stage
  - Recent data not yet analyzed
  - No agreed-upon RHIC performance expectations
- We can, however, look at
  - Where we are in achieving previously agreed physics goals and
  - What it will take to achieve them in a timely way

# From the RHI white paper for the Long Range Plan: A Strawman run program for RHIC's first years of operation*

| Year | Run Plan | | Physics |
|---|---|---|---|
| 2001-2002 | long Au + Au at 200 GeV/A<br>commission & run pp<br>Au + Au at low E: 20 GeV/A | X<br>✓<br>✓ | J/ψ, high $p_t$, multistrange<br>Comparison & spin run<br>One day at injection energy |
| 2003 | d + Au at 200GeV/A (7 wks)<br>scan lighter beams (3 x 5 w)<br>polarized pp (10 wks) | <br><br>??? | Comparison with Au+Au<br>Scan system volume<br>Spin |
| 2004 | Au + Au (10 wks)<br>polarized pp (10 wks)<br>p(d)+Au (12 wks) | | High $p_t$, observe Υ, multistrange baryon slopes<br>Comparison & spin<br>Comparison, structure fns. |
| 2005 | p + nucleus (22 wks)<br>polarized pp (10 wks) | | Comparison, Drell-Yan studies<br>Spin |
| 2006 | long Au + Au<br>lighter ion | | Open charm |

*Annotated by me

# Modifications to the Strawman

- To stay on this path, 2003 should deliver
  - The long Au-Au run
  - d-Au comparison data
  - A species scan (O? Si? Cu? …)
  - First real $\vec{p}$-$\vec{p}$ run
- Of course, the RBUPs are not required to hew to this line and may make physics cases for other conditions, e.g.,
  - Runs at specific energies
  - General energy scan
  - Other?
- Issues about this…

# Issues about this view

- Polarized proton running –
  - will we be able to do good spin physics in 2003?
  - must we have the p-p comparison running anyway?
- Running vs. Development time
  - Priority of improving average **L** and availability
- Efficient running for different configurations
  - competing needs of high integrated L and survey data
  - how much time will go into changing over?

# Assumptions: 2003 running conditions

- Based on 01/02 experience (+ some optimism) and assuming the '03 Pres. budget
  - 22 weeks of physics running
  - IR $\sigma_{diamond}$ = 22cm
  - Average luminosity in a store = design luminosity
    (though perhaps not achieved as planned)
  - 40% Machine X Detector availability

  $\Rightarrow$ ~50$\mu b^{-1}$/week observed in Au-Au @ $\sqrt{s}$ = 200GeV/A

  $\Rightarrow$ ~10$nb^{-1}$/week " " d-Au "

  $\Rightarrow$ ~2$pb^{-1}$/week " " p-p "
- These are ~equal nucleon-nucleon integrated per week
  $\Rightarrow$ equal reach (e.g., in $p_T$) $\Leftrightarrow$ ~equal running time

# 2003 running conditions

- Example run plan :
  - 300$\mu b^{-1}$ Au-Au observed (6 weeks)
  - d-Au of equal reach (6 weeks + 2-3 weeks' comm.)
  - 10$pb^{-1}$ of $\vec{p}$-$\vec{p}$ (5 weeks + 1-2 weeks' comm.)
- This looks like it fits!
  - No species or energy scans
  - Maybe room for ~1-day special runs between major blocks
- But: assumes the target running conditions throughout the run. This may be ×2 too optimistic.

# Goals and stretch goals for 2003

- If the learning/relearning curves do amount to a factor 2 down from this example run plan we probably won't get all of
  - High-statistics Au-Au, d-Au and $\vec{p}-\vec{p}$
  - Scans and special runs
- Either one reduces one's statistical sample requirements

  -or-

  spends the necessary machine development time to get better $\int L\,dt$ /week and higher availability
- I believe high priority should be put on the latter

# Back to my "Issues" slide

- Polarized proton running –
  - Will we be able to do good spin physics in 2003?
  - If so, it's a high priority
  - Can we learn this before cryo operation starts?
  - Must we have the p-p comparison running anyway?
- Running vs. Development time
  - Priority of improving average L and availability
  - Need to define a production/development schedule that's both efficient & sufficient for experiments and accelerators
- Efficient running for different configurations
  - Competing needs of high integrated L and survey data
  - How much time will go into changing over?
  - Can we look forward to robust configurations and quick changes between configurations in 2003?

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# Additional slides

# Bunch intensity, luminosity

- $L_{peak} = f_{REV} M N_a N_b / (4\pi \sigma_a^* \sigma_b^*)$
- M = # bunches = 60, N = ions/bunch,
  $\sigma^*$ = RMS beam size @ IR, $f_{REV}$ = 78kHz

| | N | σ*(μm) |
|---|---|---|
| p | $10^{11}$ | 160 |
| d | $10^{11}$ | 200 |
| Au | $10^{9}$ | 220 |

| | Peak Luminosity ($cm^{-2}sec^{-1}$) | Avg. Luminosity ($cm^{-2}sec^{-1}$) | Minbias event rate @ avg. Luminosity |
|---|---|---|---|
| Au-Au | $8x10^{26}$ | $2x10^{26}$ | 1.4kHz |
| p-p | $1.5x10^{31}$ | $1x10^{31}$ | 400kHz |
| d-Au | $8.5x10^{28}$ | $3.5x10^{28}$ | 120kHz |

[There are some guesses in here, regarding the d-beam lifetime, factors of 2 for bunch intensities, etc.]

Since d-Au multiplicities will be higher by factors of a few relative to p-p, the data load is again fairly constant across different species.

NB: the nucleon-nucleon luminosities are ~the same for the 3 cases!